HMC994APM5E

v05.0823

GaAs pHEMT MMIC POWER AMPLIFIER, DC - 28 GHz

Typical Applications

The HMC994APM5E is ideal for:

- Test Instrumentation
- Military & Space
- Fiber optics

Features

P1dB Output Power: +28 dBm

Psat Output Power: +29 dBm

High Gain: 15 dB

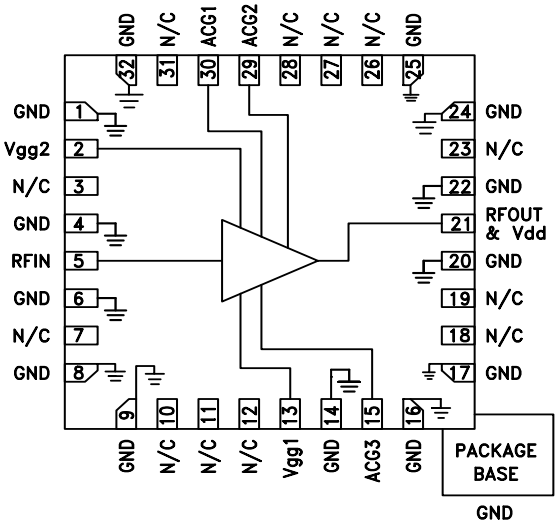
Output IP3: +38 dBm

Supply Voltage: Vdd = +10V @ 250 mA

50 Ohm Matched Input/Output

32 Lead 5x5 mm SMT Package: 25 mm²

Functional Diagram



General Description

The HMC994APM5E is a GaAs pHEMT MMIC Distributed Wideband Power Amplifier which operates between DC and 28 GHz. The amplifier provides 15 dB of gain, +29 dBm of saturated output power, and 25% PAE from a +10V supply. With up to +38 dBm Output IP3 the HMC994APM5E is ideal for high linearity applications in military and space as well as test equipment where high order modulations are used. The HMC994APM5E exhibits a positive gain slope from 2 to 20 GHz making it ideal for EW, ECM, and test equipment applications. The HMC994APM5E amplifier I/Os are internally matched to 50 Ohms and is packaged in a leadless QFN 5x5 mm surface mount package.

Electrical Specifications, T_A = +25° C, Vdd = +10V, Vgg2=3.5V Idd = 250 mA [1]

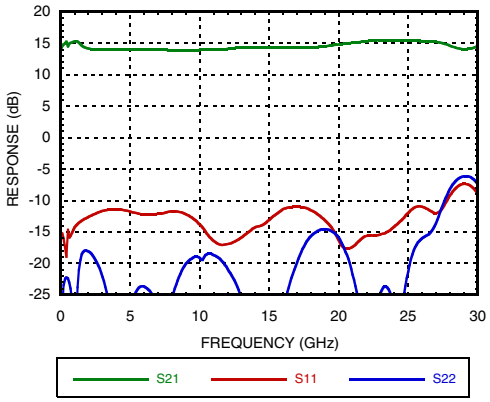
Parameter	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ..	Max.	Units
Frequency Range		DC - 10			10 - 20			20 - 28		GHz
Gain	12	14		12	15		13	16		dB
Gain Flatness		±0.5			±0.5			±0.5		dB
Gain Variation Over Temperature		0.008			0.011			1.016		dB/ °C
Input Return Loss		12			12			12		dB
Output Return Loss		25			22			20		dB
Output Power for 1 dB Compression (P1dB)	26	28		26	28		25	27		dBm
Saturated Output Power (Psat)		30			29.5			28		dBm
Output Third Order Intercept (IP3) Pout/tone = +16dBm		40			38			36		dBm
Noise Figure		4			3.5			4		dB
Supply Current (Idd)		250			250			250		mA
Supply Voltage (Vdd)	8	10	11	8	10	11	8	10	11	V

[1] Adjust Vgg1 to achieve Idd = 250 mA typical; Vgg1 = -0.50V typical.

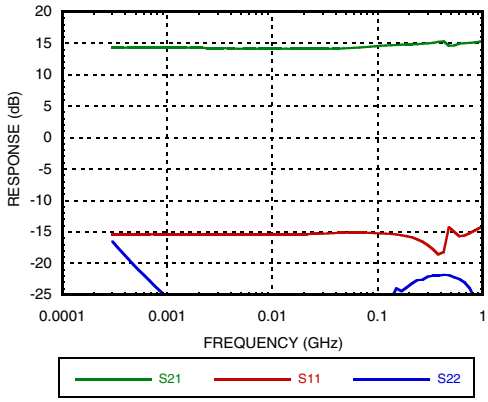
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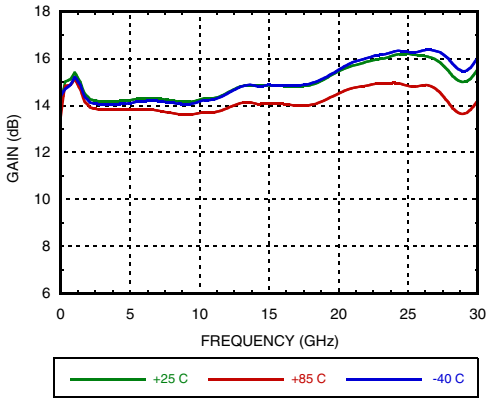
Gain & Return Loss



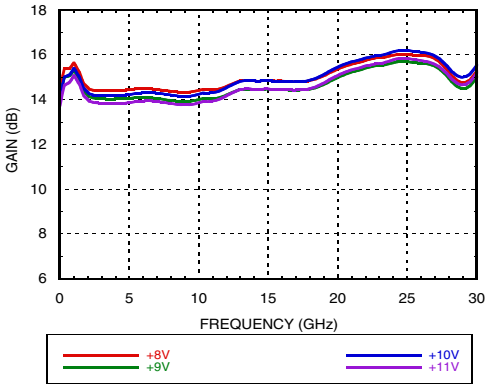
Low Frequency Gain & Return Loss



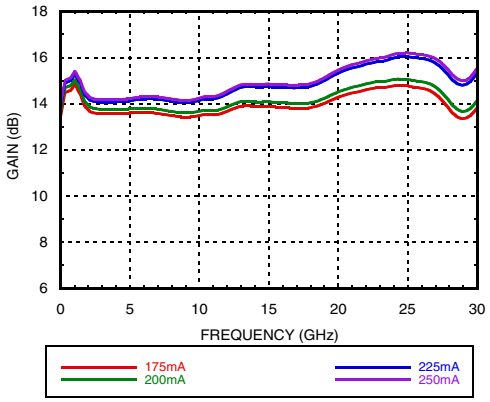
Gain vs. Temperature



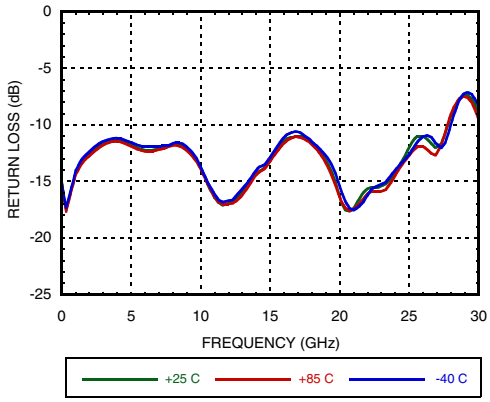
Gain vs. Vdd



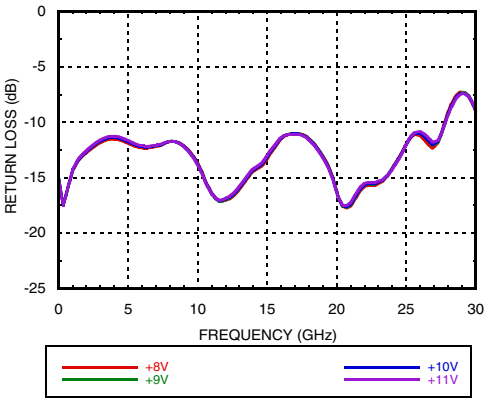
Gain vs. Idd



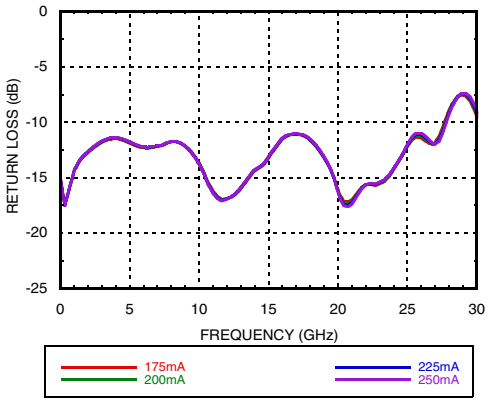
Input Return Loss vs. Temperature



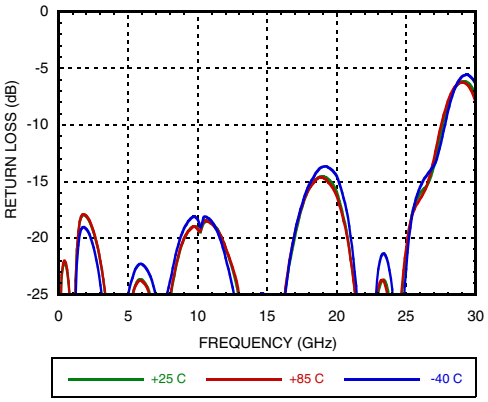
Input Return Loss vs. Vdd



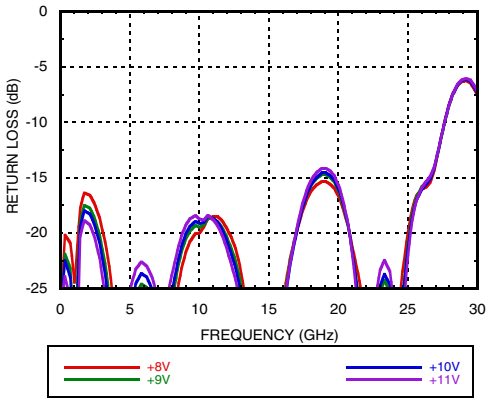
Input Return Loss vs. Idd



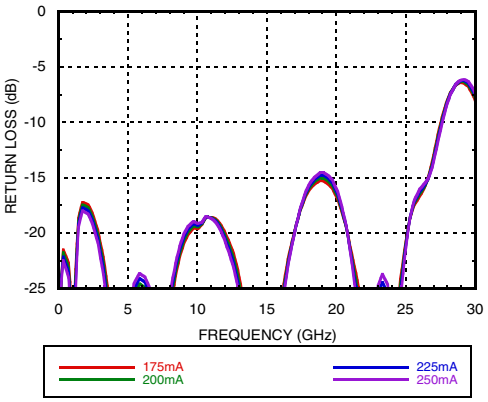
Output Return Loss vs. Temperature



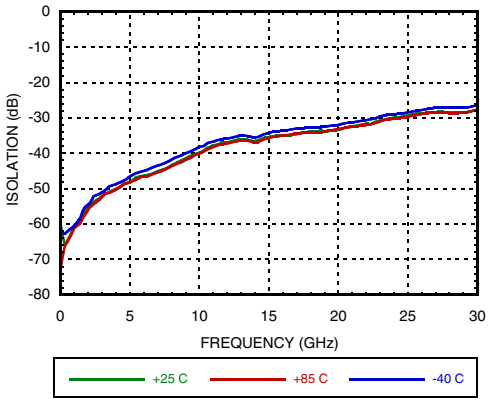
Output Return Loss vs. Vdd



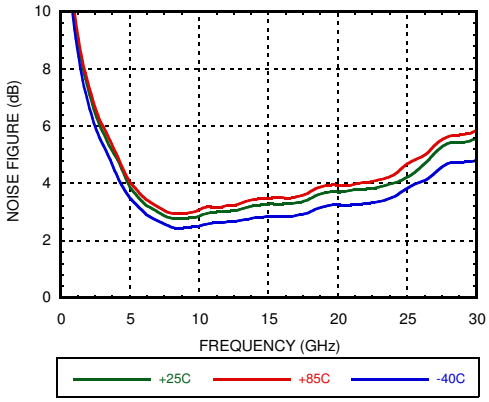
Output Return Loss vs. Idd



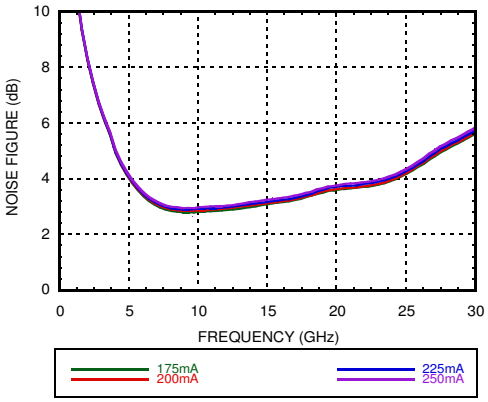
Reverse Isolation vs. Temperature



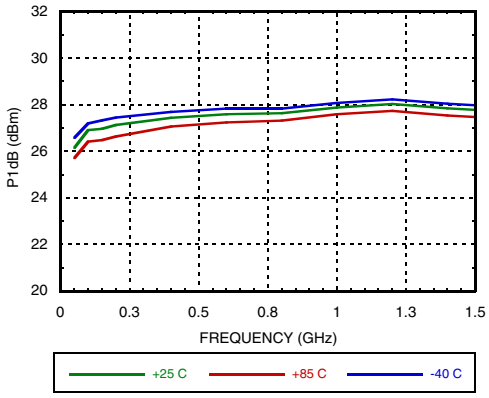
Noise Figure vs. Temperature



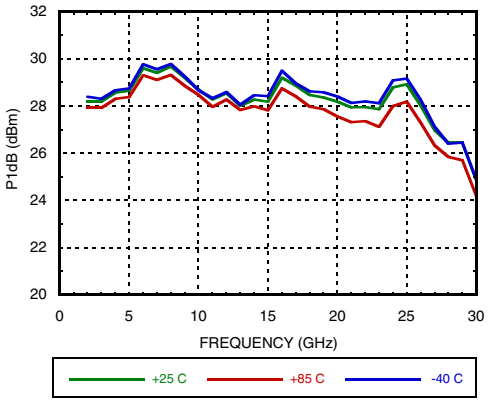
Noise Figure vs. Idd



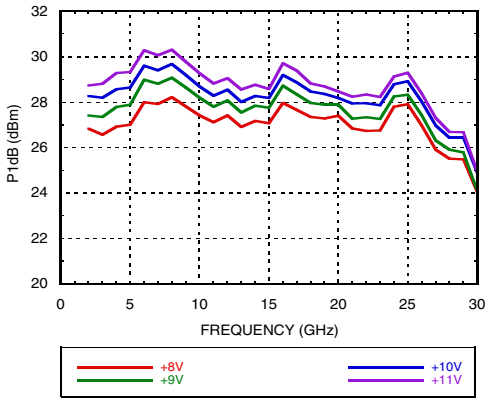
Low Frequency P1dB vs. Temperature



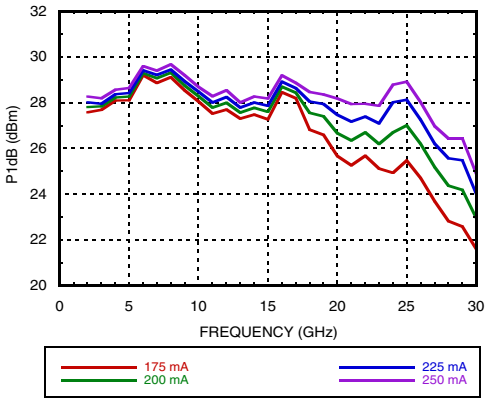
P1dB vs. Temperature



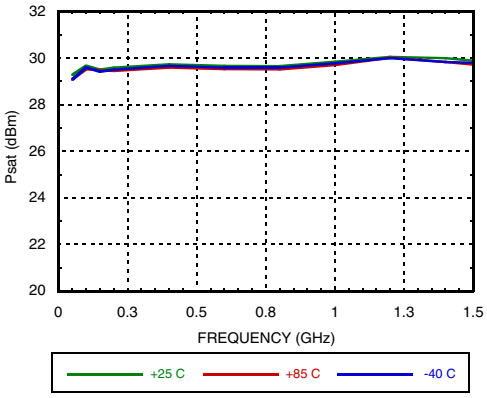
P1dB vs. Vdd



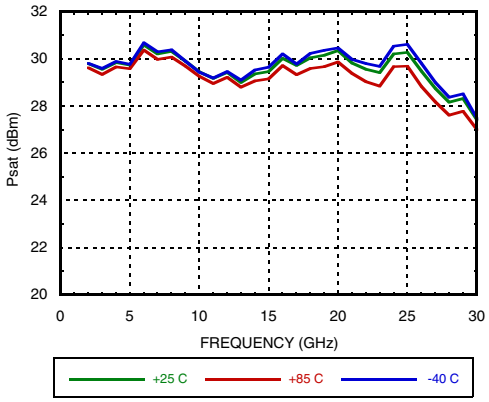
P1dB vs. Idd



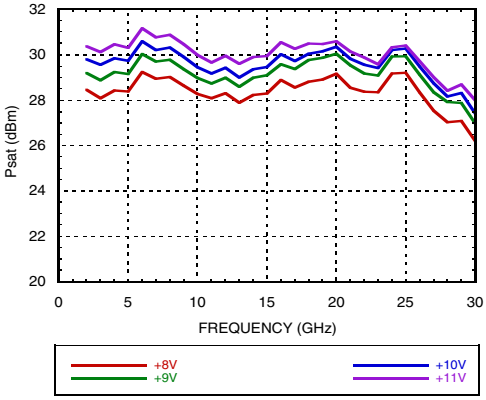
Low Frequency Psat vs. Temperature



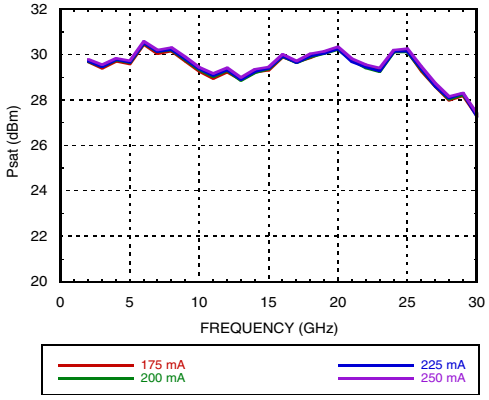
Psat vs. Temperature



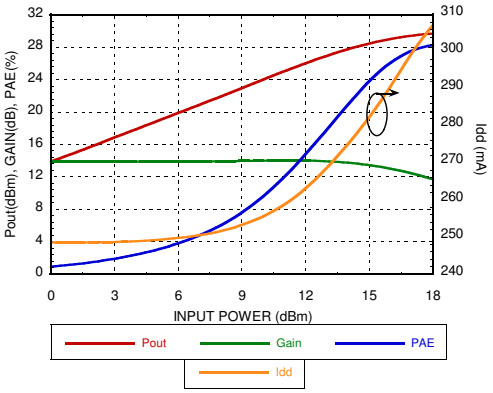
Psat vs. Vdd



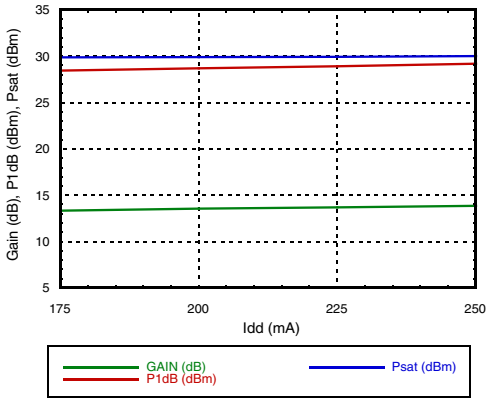
Psat vs. Idd



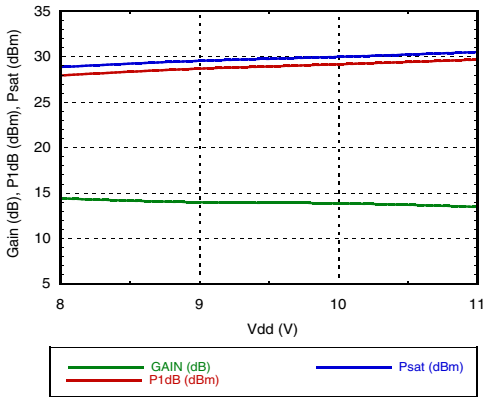
Power Compression @ 16 GHz



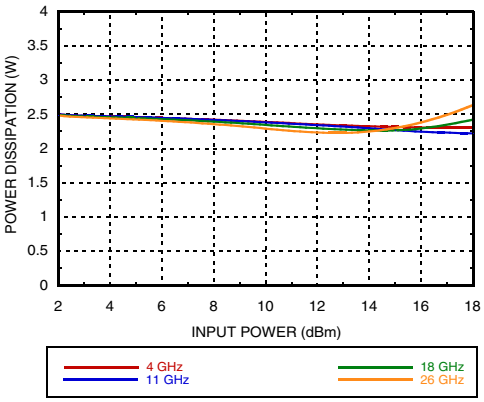
Gain & Power vs. Idd @ 16GHz



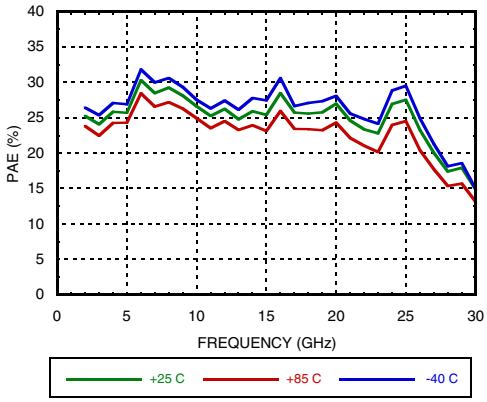
Gain & Power vs. Vdd @ 16 GHz



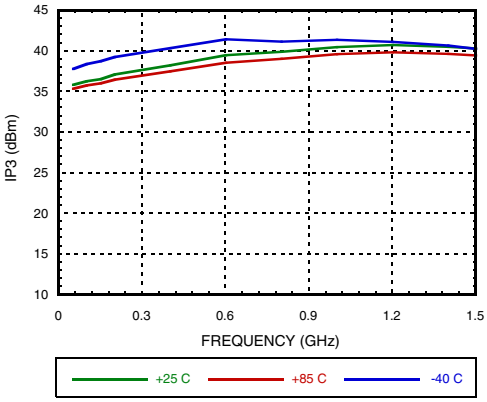
Power Dissipation



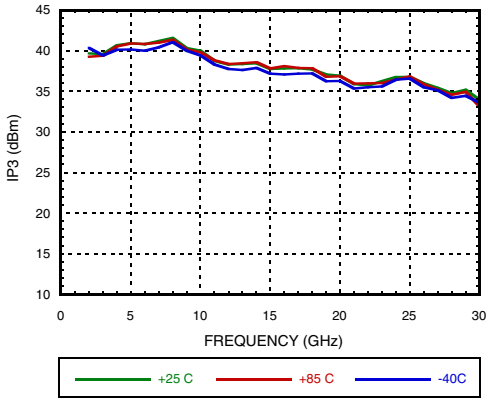
PAE @ Psat vs. Frequency



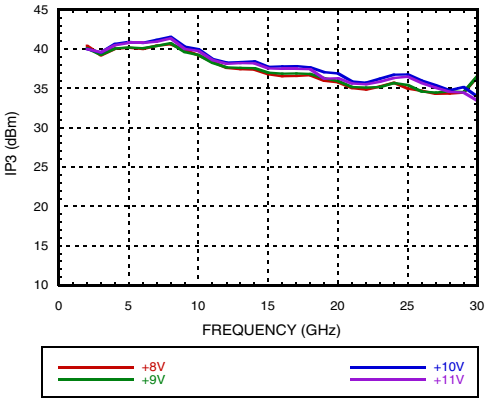
Low Frequency OIP3 vs. Temperature @ Pout/tone = +16dBm



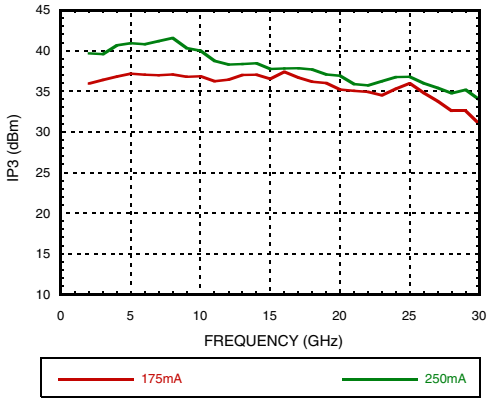
OIP3 vs. Temperature @ Pout/tone = +16dBm



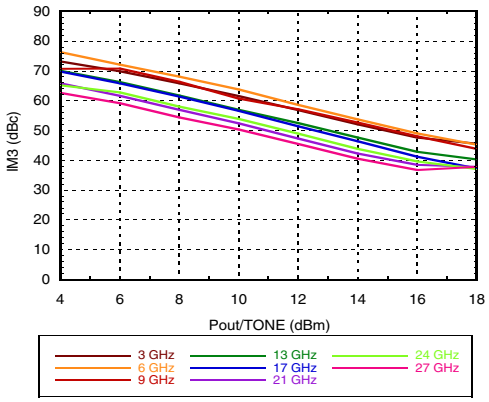
OIP3 vs. Vdd @ Pout/tone = +16dBm



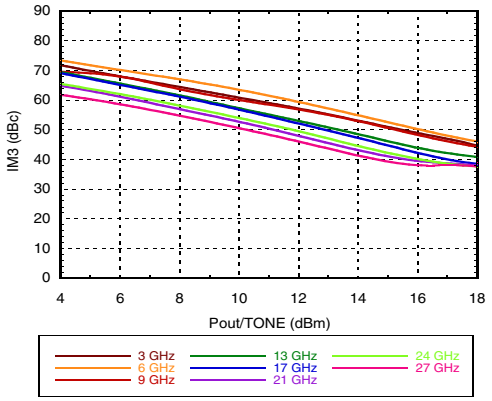
OIP3 vs Idd @ Pout/tone = +16dBm



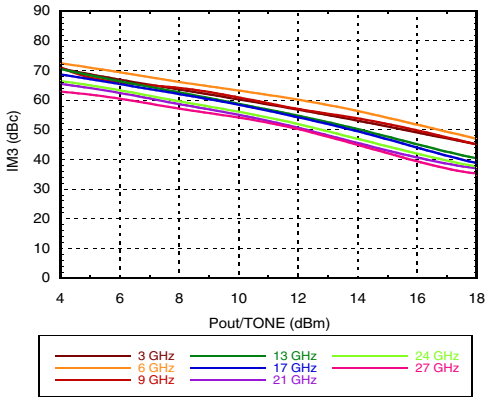
Output IM3 @ Vdd = 8V



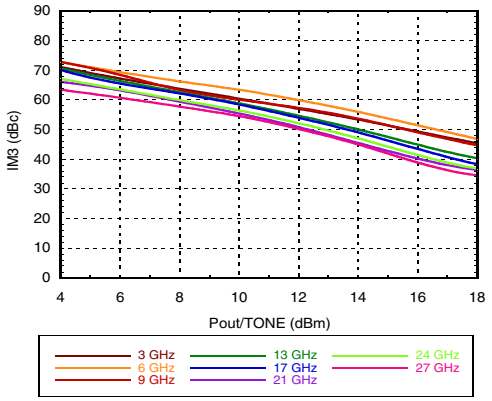
Output IM3 @ Vdd = 9V



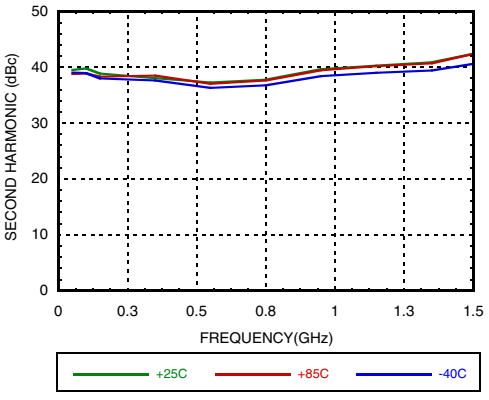
Output IM3 @ Vdd = 10V



Output IM3 @ Vdd = 11V

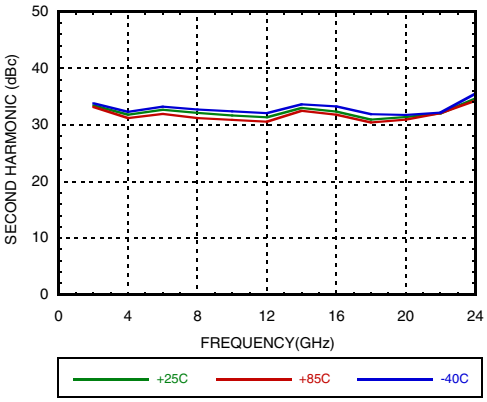


Low Frequency Second Harmonics vs. Temperature @ Pout = +14dBm

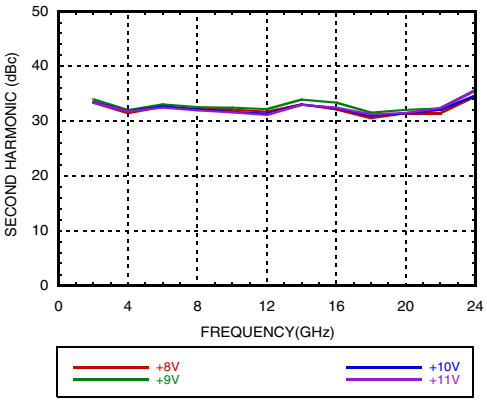


GaAs pHEMT MMIC POWER AMPLIFIER, DC - 28 GHz

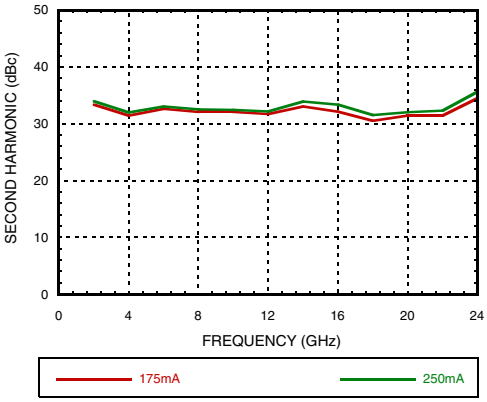
Second Harmonics vs. Temperature @ Pout = +14dBm



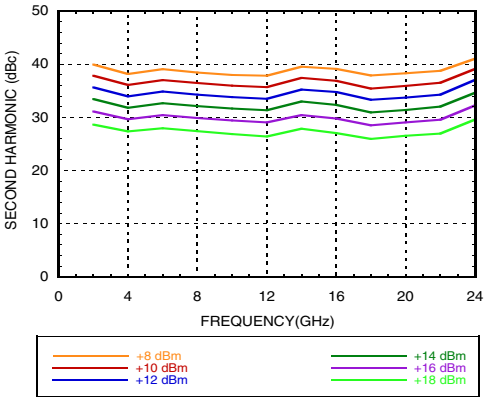
Second Harmonics vs. Vdd @ Pout = +14dBm



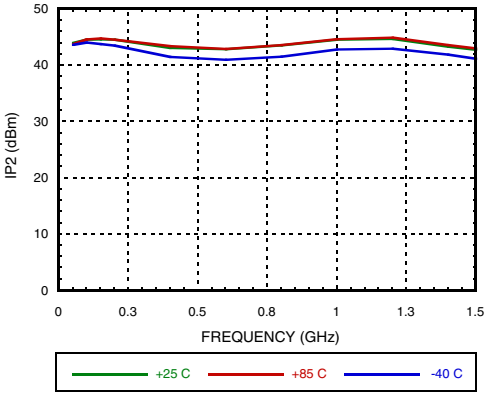
Second Harmonics vs Idd @ Pout = +14dBm



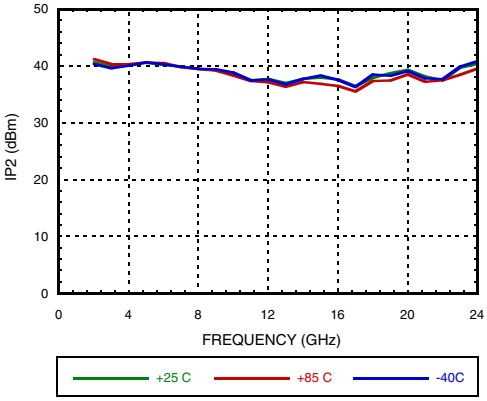
Second Harmonics vs. Pout



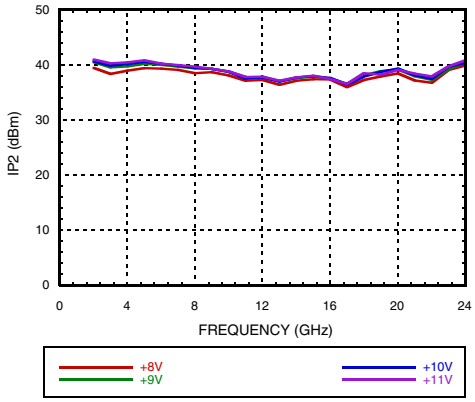
Low Frequency OIP2 vs. Temperature @ Pout/tone = +16dBm



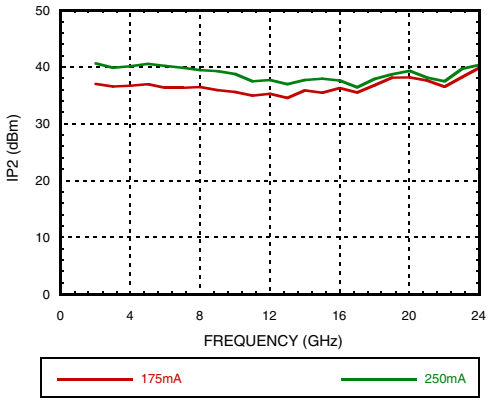
OIP2 vs Temperature @ Pout/tone = +16dBm



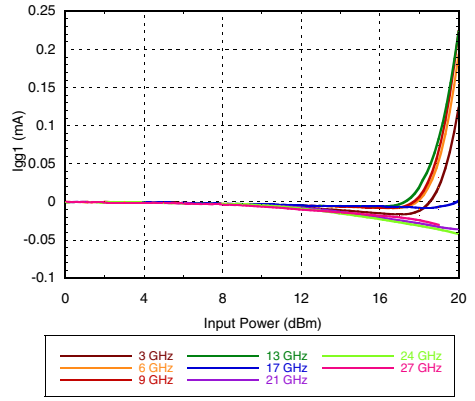
OIP2 vs Vdd @ Pout/tone = +16dBm



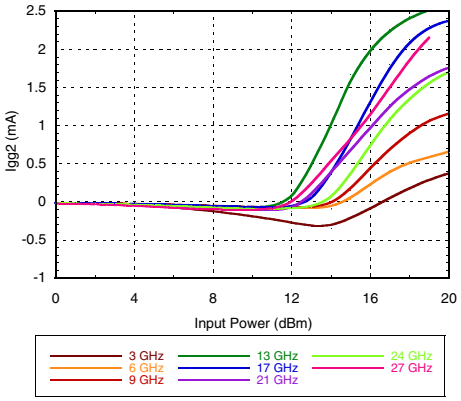
OIP2 vs Idd @ Pout/tone = +16dBm



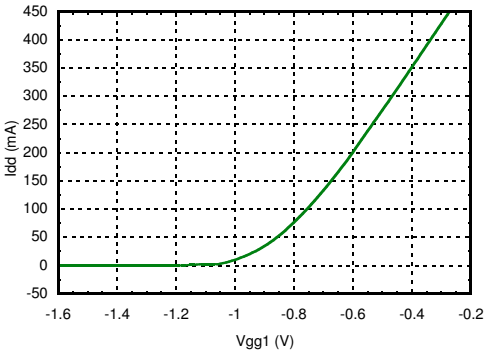
Igg1 vs. Input Power



Igg2 vs Input Power



Idd vs Vgg1, Representative of a Typical Device



GaAs pHEMT MMIC POWER AMPLIFIER, DC - 28 GHz

Absolute Maximum Ratings

Drain Bias Voltage (Vdd)	+12 Vdc
Gate Bias Voltage (Vgg1)	-3 to 0 Vdc
Gate Bias Voltage (Vgg2)	2.5V min up to (Vdd - 5.5V)
RF Input Power (RFIN)	+25 dBm
Continuous Pdiss (T= 85 °C) (derate 38.9 mW/°C above 85 °C)	3.5 W
Output Load VSWR	7:1
Storage Temperature	-65 to 150°C
Operating Temperature	-40 to 85 °C
ESD Sensitivity (HBM)	Class 0B, passed 150V.

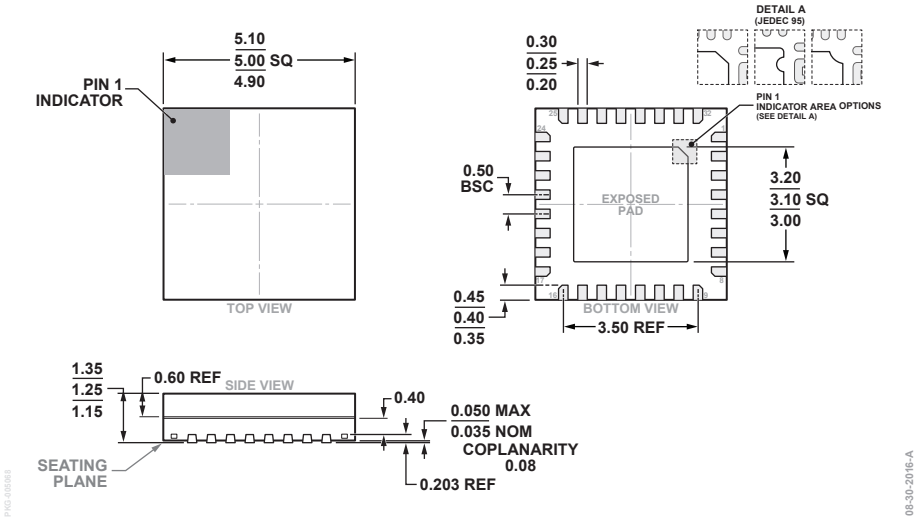
Reliability Information

Maximum Channel Temperature	175 °C
Thermal Resistance (channel to ground paddle)	25.7 °C/W

ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only, functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

Outline Drawing



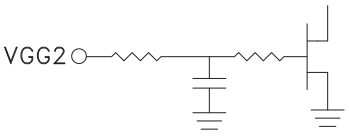
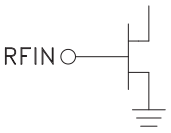
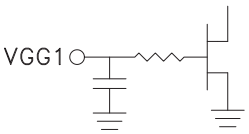
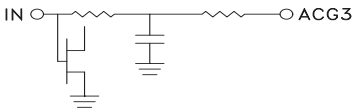
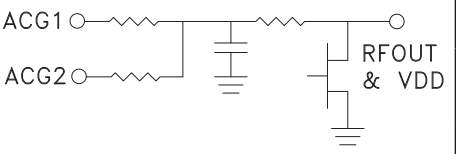
32-Lead Lead Frame Chip Scale Package, Premolded Cavity [LFCSP_CAV]
5 mm × 5 mm and 1.25 mm Package Height
(CG-32-2)

Package Information

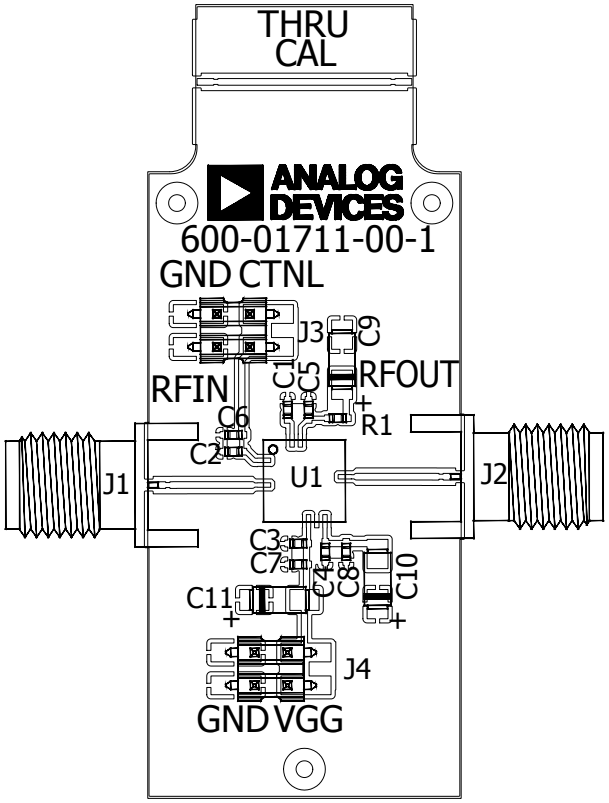
Part Number	Package Body Material	Lead Finish	MSL Rating [1]	Package Marking
HMC994APM5E	RoHS-compliant Low Stress Pre-Molded Plastic	NiPdAu	MSL3	HMC994A

[1] Max peak reflow temperature of 260 °C

Pin Descriptions

Pin Number	Function	Description	Interface Schematic
1, 4, 6, 8, 9, 14, 16, 17, 20, 22, 24,25, 32 Package Bottom	GND	These pins & exposed ground paddle must be connected to RF/DC ground.	
2	VGG2	Gate control 2 for amplifier. Attach bypass capacitor per application circuit herein. For nominal operation +3.5V should be applied to Vgg2	
3, 7, 10, 11, 12, 18, 19, 23, 26, 27, 28, 31	N/C	No connection required. These pins may be connected to RF/DC ground without affecting performance.	
5	RFIN	This pin is DC coupled and matched to 50 Ohms. Blocking capacitor is required.	
13	Vgg1	Gate control 1 for amplifier. Attach bypass capacitor per application circuit herein. Please follow “MMIC Amplifier Biasing Proceedure” application note.	
15	ACG3	Low Frequency termination. Attach bypass capacitor per application circuit herein.	
21	RFOUT & Vdd	RF output for amplifier. Connect DC bias (Vdd) network to provide drain current (Idd). See application circuit herein.	
29	ACG2	Low frequency termination. Attach bypass capacitor per application circuit herein	
30	ACG1		

Evaluation PCB



Note:
VGG = VGG1
CTNL = VGG2

Evaluation Order Information

Item	Contents	Part Number
Evaluation PCB Only	HMC994APM5E Evaluation PCB	EV1HMC994APM5[1]

[1] Reference this number when ordering Evaluation PCB Only

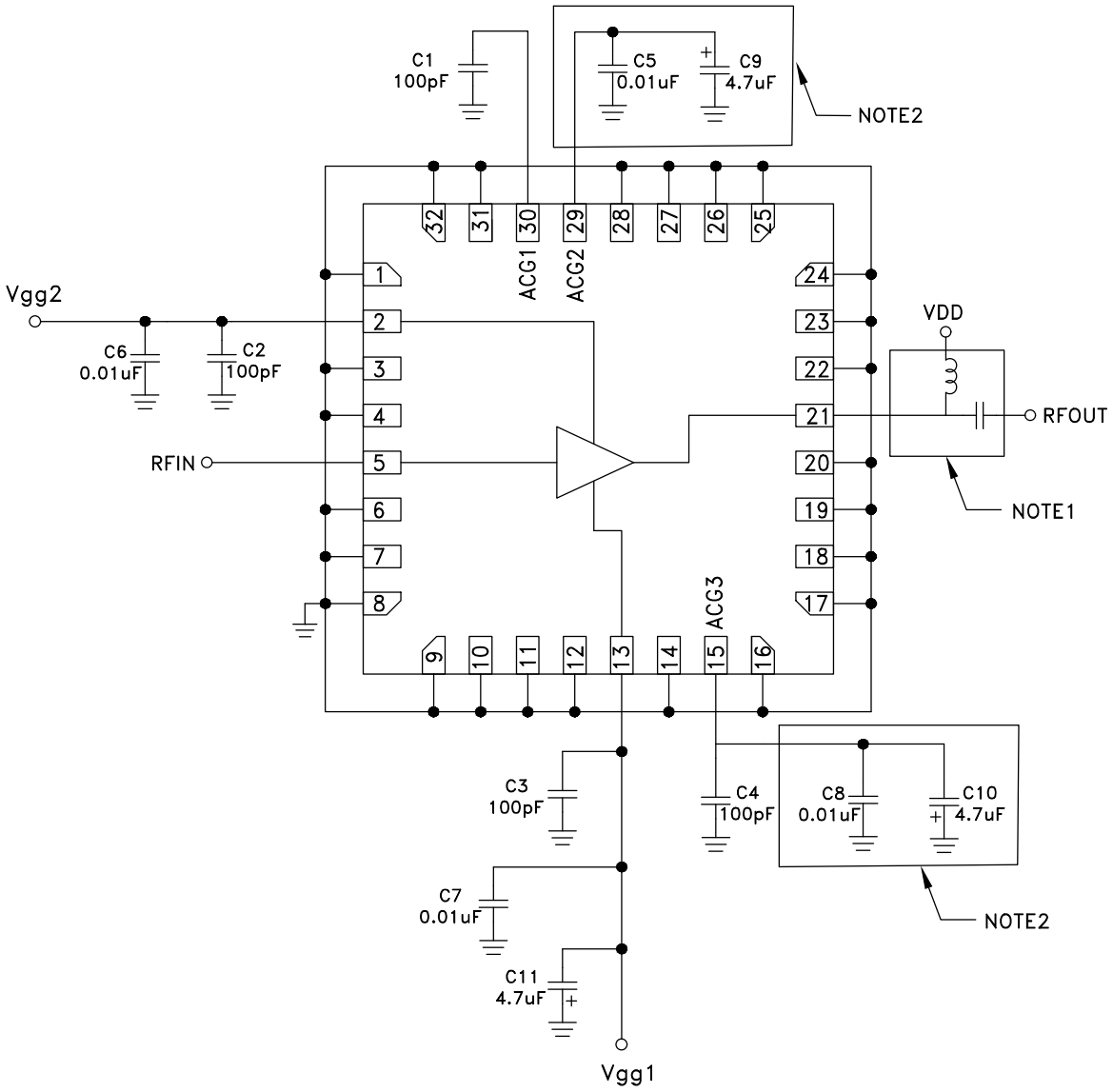
List of Materials for Evaluation Board EV1HMC994APM5

Item	Description
J1, J2	PCB Mount K Connector
J3, J4	DC Pins Connector
C1 - C4	100 pF Capacitor, 0402 Pkg.
C5 - C8	0.01uF Capacitor, 0402 Pkg.
C9 - C11	4.7 uF Capacitor, Tantalum.
R1	0 Ohm Resistor, 0402 Pkg.
U1	HMC994APM5E
PCB [1]	600-01711-00 Evaluation PCB.

[1] Circuit Board Material: Rogers 4350 or Arlon 25FR

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available from Analog Devices upon request.

Application Circuit



NOTE 1: Drain Bias (Vdd) must be applied through a broadband bias tee or external bias network.
NOTE 2: Optional capacitors to be used if part is to be operated below 200MHz.

Notes